

On the Use of Social Clocks for the Monitoring of Multidimensional Social Development

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Accepted: 6 September 2010 / Published online: 12 October 2010
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Abstract This article describes a new methodology for monitoring multidimensional social development using social clocks: comparisons with so called reference trajectories make it possible to establish the development stage of a country along a number of independent time axes, thus affording new opportunities for analyzing leads, lags, and asynchronies between variables and countries. This article explores these new possibilities and discusses some of the difficulties in the use of social clocks. To demonstrate the fruitfulness of the new concepts, the article presents an application of the methodology by analyzing the socio-economic development of ten Eastern European countries in the period before they joined the European Union.

Keywords Methodology · Social time · Asynchronies · Time leads · Time lags · Social development · Eastern Europe

1 Introduction

This paper tackles the methodological problems of monitoring multidimensional social development. While multidimensionality itself is not a problem, as national societies can be described with many different indicators such as income per capita, infant mortality rates, or school enrolment, (see e.g. World Bank 2008; OECD 2009, etc.) problems arise when data have to be *compared* between variables, different national societies, or across periods of calendar time.

The most difficult of these three cases is the comparison between different *variables*, all describing the development of a given national society: due to the heterogeneity of the physical, economic, and social dimensions, it is not usually possible to identify the leading or lagging dimensions of the stage of development of a country. Comparisons between nations or between time-points with regard to a single development variable are far easier.

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But even here, differences and changes are sometimes hard to assess in quantitative terms, to establish, for example, how *far* one country is ahead of others, or what a “normal” change between two points in calendar-time might be.

For these problems, the solution proposed in this article is to compare the development of a country with a reference trajectory and to determine the time lead or lag of the country with regard to this benchmark. In this way it becomes possible to construct for each development dimension a *social clock*, which can be used for a comparative description of the progress of countries in terms of *social time*.

As will be shown in Sect. 3 by a practical example from Eastern Europe, the use of social clocks solves indeed the mentioned problems of comparison. But this method also raises new problems and research questions, which have to be tackled in this article.

One of the problems is that the different social clocks each run at their own pace and thus are not necessarily synchronized. This raises new research questions about the *dimensionality* of social time. Is social time uni- or multidimensional? And what are the *methods* which will make it possible to determine this dimensionality? In Sect. 3.3 of this article we try to answer these new research questions.

Similarly, it is also problematic that the results of the previous descriptions and analyses depend on the choice of the reference trajectories of the mentioned social clocks: for example, reference trajectories representing best practice may give different results from those based on mean values of development. Consequently, this article also explores the relations between different possible reference trajectories. This leads to a *typology of reference systems*, which facilitates the identification of the best possible reference trajectory for a given purpose.

2 Measuring Social Time

2.1 Social Clocks

Scientific interest in social development is fueled by the fact that this type of social change is a disequilibrating process, which tends to generate all kinds of leads and lags. Following a seminal idea of Sicherl (1978, 1992), we give these leads and lags a clearly *temporal*

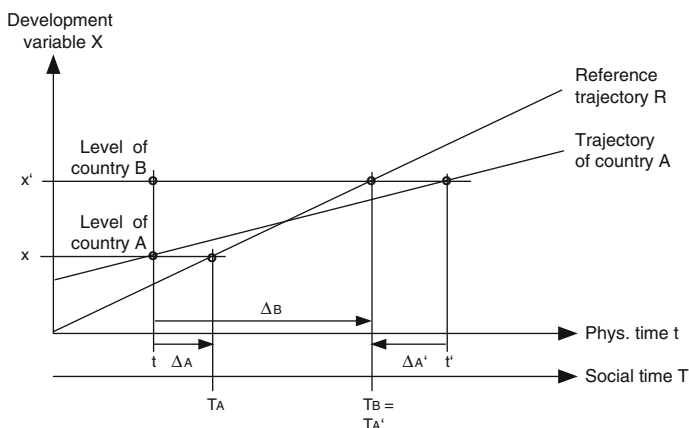


Fig. 1 The measurement of social time by a social X-clock

interpretation: we try to find out how many years a national society is ahead of or behind a given referential development trajectory. For this purpose, we identify the physical time-point T_A , when the reference trajectory R was at the same level of development x as the country A in the year t (see Fig. 1). In the example of Fig. 1, the difference $\Delta_A = T_A - t$ is *positive* and thus represents a time lead of the country A over the mentioned reference R . If it were *negative*, we would consider it a time lag. Thus, $T_A = t + \Delta_A$ is the *social time* of the country A with regard to its development X at physical time t . In general, social time T_A is different from the mentioned corresponding time-point t . In what follows, the formal *procedure* used to identify the social time T_A will be referred to as the *social X-clock*. From the mathematical point of view, it is the inverse function of the reference trajectory R : its input is a level of development x , which returns as an output the social time T_A .

Social clocks which refer to one single variable X can be used for two different types of comparisons, both shown in Fig. 1: One of them is *synchronic* comparison between two countries A and B , which at physical time t were at the levels of development x and x' , respectively. As the social X -clock returns for x and x' the social times T_A and T_B (see Fig. 1), country B is $T_B - T_A$ units of time ahead of country A . This means that the reference trajectory R needs $T_B - T_A$ units of time in order to climb from development level x to the development level x' .

The second type of comparisons, for which X -clocks are suitable, is *diachronic* analysis of the development of a single country A at two subsequent physical time-points t and t' . In the example of Fig. 1, the corresponding social time T_A' lags with regard to R by Δ_A' units of time, whereas T_A is ahead of R . In sum, from physical time t to t' , the social X -clock advances by $T_A' - T_A$ time-units. If $T_A' - T_A$ were greater than the change $t' - t$ in physical time, country A would be *over-performing* as compared to the reference trajectory R : due to the self-referential nature of the social time of R , it advances at the same pace as the physical time t . In the example of Fig. 1, $T_A' - T_A < t' - t$ such that country A is *de facto* rather *under-performing*. If $T_A' - T_A$ were not positive but equal to *zero*, the development of country A would be *stagnant*. In the worst case, it is even possible that $T_A' - T_A < 0$: in this situation $T_A' < T_A$ and the social time of country A is *reverting* to the historical past, whereas the physical time t is progressing at normal speed. To sum up, the flow of social time is not necessarily a steady linear process (Adam 1995: 29 ff.; Zerubavel 2003: Chap. 4).

Figure 1 is in several ways a simplification of reality. On the one hand, the country- and reference trajectories in Fig. 1 are always linear. In practice, however, reference trajectories tend to be positive monotonic and country trajectories can be of nearly any shape at all. The previous definitions of time leads and lags on the base of Fig. 1 obviously also hold for the mentioned non-linear case. On the other hand, Fig. 1 simplifies the real situation, since there are in practice not only one but *many different social clocks*, all representing dimensions of social development (Sablier 1997: 78 ff.). The fact that these clocks are not necessarily synchronized rises new research questions and problems, which will be discussed in the following Sect. 2.2. Finally, there are many possible *reference trajectories*, of which a single appropriate one has to be selected (Allan 1987). This further complicates the measuring of social time and thus requires a special discussion in Sect. 2.3.

2.2 Clock Systems

The analysis of multidimensional social development entails the introduction of a separate social clock for each dimension of development. Figure 2 illustrates the situation for a relatively simple case with only two dimensions X and Y : at physical time t , country A is

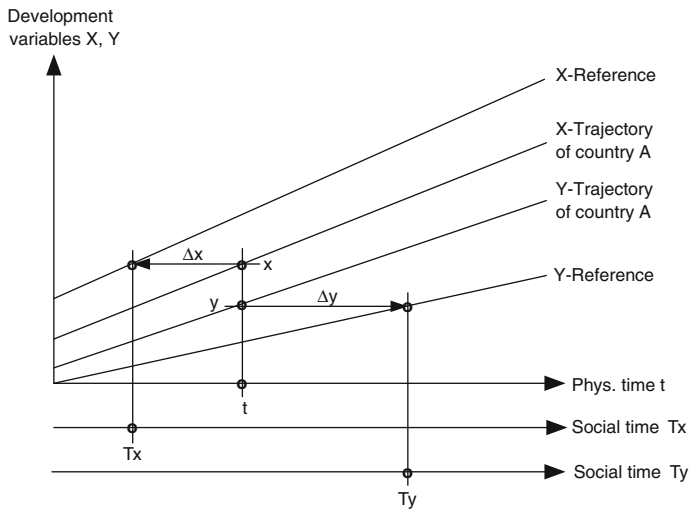


Fig. 2 Measuring the asynchronies between different development dimensions

on the X-clock relatively lagged, i.e. still at social time T_x . However, with regard to variable Y the same country is ahead of the reference trajectory, i.e. in a rather different period of social time T_y . This difference in social time $T_y - T_x$ may be considered to be an indicator of an *asynchrony* between two processes of development. It can be either positive or negative, depending on which variable is leading.

Often in reality there are not only two but n social clocks, thus allowing $n \times (n - 1)/2$ different comparisons. Some of these clocks are perfectly autonomous, while others are *coupled* and thus constitute *clock systems*. One way to study such clock systems is with statistical regression, by means of which social time on one clock is explained by social time on others (Mueller 2005a, b). A less sophisticated form of analysis is the empirical determination of the number of autonomous clock systems using statistical techniques like e.g. *principal component* analysis (Kim and Mueller 1998; Tabachnick and Fidell 2007: Chap. 13). The result can be interpreted as the *dimensionality of social time* with regard to a multidimensional social development. Due to the synchronization of social clocks, this dimensionality is generally lower than the number n of development variables.

2.3 Reference Systems

The previous two sections of this article might have suggested that for each social clock there is only one reference for measuring social time. De facto, however, there are many alternative reference trajectories. For example, each country-specific trajectory with regard to a development variable X defines in a “natural way” a reference, which can be used by the national population to evaluate both their own development as well as the development of the neighboring countries. Alongside these “natural” reference trajectories researchers have added more “artificial” ones, such as the median trajectory, the mean trajectory, or the best practice trajectory.

Figure 3 makes clear that each country-specific reference trajectory translates a given level of development x at a physical calendar time t into a different social time T_R or T_Q . As a general rule, from the perspective of a neighbor country with a relatively low

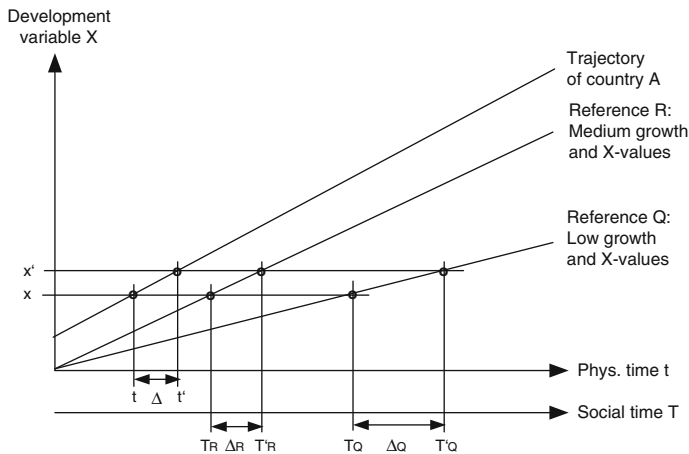


Fig. 3 The influence of the reference system on social time and velocity

development X (see reference Q in Fig. 3) country A is seen as more advanced in terms of *social time* T_Q than from the perspective of a different neighbor country with a more developed reference trajectory R , which for the same level of development x yields the social time T_R . Similarly, the *velocity* of the development of the country A with regard to a given variable X also depends on the growth of the reference R or Q : for a constant time-interval $[t, t']$, clocks with *rapidly* growing reference trajectories (see reference R in Fig. 3) yield *lower* relative changes $\Delta_R = (T'_R - T_R)/(t' - t)$ than clocks with a *slower* growing reference Q , for which the corresponding velocity equals $\Delta_Q = (T'_Q - T_Q)/(t' - t)$. These considerations obviously also hold for *non-linear* trajectories, not shown in Fig. 3, if the concept of velocity is interpreted as the *average* velocity between two physical points in time t and t' .

For empirical analyses it is often impractical to have too many different neighbor-trajectories and measurements of social time. One way of reducing this complexity is to analyze the proximity of the different reference trajectories on the basis of their assessment of the development of other countries. For this purpose, *hierarchical cluster analysis* (Aldenderfer and Blashfield 1991: 35 ff.; Everitt 1993: 55 ff.) is a useful statistical technique as it yields systems of equivalent references. Another way to reduce the complexity of alternative references is to take a *theoretically* founded decision about the optimal reference trajectory for a given purpose: mean or median trajectories e.g. may be acceptable as summaries of the many individual trajectories of countries. Finally, *combinations* of these theoretical and statistical approaches may also be helpful for finding a single appropriate reference for the construction of a social clock.

3 An Example: The Social Clocks of Eastern Europe

3.1 The Measurement of Social Time

In the following, the methodological ideas presented in Sect. 2 will be used for monitoring the development of a sample of ten Eastern European countries: Bulgaria (BG), the Czech Rep. (CZ), Estonia (EE), Hungary (HU), Latvia (LV), Lithuania (LT), Poland (PL),

Romania (RO), Slovenia (SI), and Slovakia (SK). These countries share a communist past and have all joined the EU, either in 2004 or 2007. Since this important transition was realized in less than 20 years, it required enormous political, economic, and social changes, which make these countries of particular interest for developmental analyses (Schadler et al. 2006; Jakubowicz 2007: Chap. 2, 3). As their post-communist history is rather limited in time, we had to confine the analysis of these ten countries to the period from 1997 to 2007, for which Eurostat (2010a) has appropriate and reliable statistical figures. Moreover, for reasons of research economics, we concentrated on a small number of important development variables, which refer in one way or another to the satisfaction of human needs:

- a. PHONE: The number of *mobile phones* per 100 inhabitants (source: Eurostat 2010b). The indicator stands for the satisfaction of communication needs.
- b. EDUC: The percentage of the population at age 18 which is enrolled at any *educational institution* (source: Eurostat 2010c). EDUC is a measure of post-modern self-actualization (Inglehart 1977, 1997).
- c. INPCP: The *income per capita*, i.e. gross domestic product per inhabitant, at current prices (source: Eurostat 2010d). INPCP is generally considered as a proxy for wealth.
- d. IMORT: The *infant mortality* below the age of 12 months, per 1000 life births (source: Eurostat 2010e). The indicator stands for the satisfaction of health needs by an appropriate medical infrastructure.

In a first step, the original figures describing these ten countries were used to calculate *median* trajectories as the references of the social clocks for PHONE, EDUC, INPCP, and IMORT. The justification for the use of these trajectories is given in the next Sect. 3.2, where alternative types of references will also be discussed. In the second step, the original Eurostat data were used to measure social time for the ten analyzed countries, in exactly the way described in Fig. 1. One problem often encountered was that the time-series of the median trajectories were not long enough in order to translate national data into social time. In this situation, we assigned the codes 2008 or 1996 to national data-points greater or smaller than the extreme values of the corresponding median trajectory in order to indicate a relatively high or low point on the social time axis.

3.2 Alternative Reference Systems

As we saw in Sect. 2.3, the most “natural” references for social clocks are the country-specific trajectories. In the present study, these are the trajectories of ten East European countries, which describe their country-specific development with regard to PHONE, EDUC, INPCP, and IMORT. Each of these trajectories was used to evaluate in terms of social time the development of that country and of the nine others. As predicted earlier, the result gives an extremely heterogeneous picture of the temporal stages of development of the ten countries. Table 1 presents the countries with the most *heterogeneous* assessments by others. With the exception of Slovenia, they are typically countries at a middle level of development. Moreover, the heterogeneity of assessments seems to be clock-dependent and increases from the left to the right of Table 1: Whereas for PHONE the standard deviations are relatively small, for IMORT they are so high that the different estimations of time can hardly be compared.

The heterogeneity of the temporal assessments of development displayed in Table 1 calls for a classification of the reference trajectories on the basis of their mutual similarities. One of the statistical techniques, which can be used for this purpose, is *hierarchical cluster analysis* (Aldenderfer and Blashfield 1991: 35 ff., Everitt 1993: 55 ff.). Here it is

Table 1 Countries with the highest standard deviations (SD) of assessments by the different national reference trajectories of their neighbors

	PHONE-time	EDUC-time	INCP-time	IMORT-time
Maximum SD	1.60	3.27	3.98	4.82
Max. SD country	Slovakia	Slovenia	Lithuania	Estonia

Calendar year of the original data: 2002. Sample for calculation of SD: 8–10 countries

Calibration: 1 SD = 1 calendar year

applied to time-measurements by ten different country-specific clocks, each of which is represented by a separate variable. The statistical procedure starts with an initial clustering, where each cluster contains just one country and its clock. Subsequently, in order to be able to fuse pairs of clusters, correlations are calculated between the assessments of the ten countries by the different country-specific clocks. In the following step, two clusters are fused, whenever all correlations between any pair of clocks from the two clusters are higher than the analogous correlations of any alternative clusters that could also be fused. This *furthest neighbor/complete linkage* clustering process (Everitt 1993: 60–61) can be continued until there is only one cluster, comprising all country-specific clocks. Hierarchical cluster analysis produces classification trees (dendrograms), as presented in Fig. 4a–d for PHONE-, EDUC-, INCP-, and IMORT-clocks. The start and the end of the classification process are trivial and of no practical interest. The methodological literature (Aldenderfer and Blashfield 1991: 53 ff.) suggests ceasing the unification of clusters, if the correlations between the fused clusters suddenly decrease. In what follows, this *elbow-criterion* is used in order to find the optimal clustering of clocks with country-specific trajectories.

For the country-specific PHONE-clocks, the clustering process described above does not yield any classification at all. According to Fig. 4a, the changing correlations of cluster unifications do not display any “elbow” and consequently there is just one all-inclusive mega-cluster. This is not so surprising, as for PHONE-time Table 1 shows only slight differences between country-specific trajectories.

However, for the country-specific EDUC-clocks (see Fig. 4b), there seem to be two clusters: a small one with the educational laggards Bulgaria (BG) and Romania (RO), and a rather large cluster of the remaining countries. In view of the earlier theoretical discussion in Sect. 2.3 about deviant social time measurements by trajectories with very low or very high development values (see Fig. 3), it is not surprising that the educational laggards Bulgaria and Romania are in a separate cluster. From this perspective, also Fig. 4c is also quite easy to interpret. For the INCP-clocks there seem to be two types of national trajectories: those of the richer countries Hungary (HU), the Czech Rep. (CZ), and Slovenia (SI), which have separate standards for assessing the income per capita of others, and those of the majority of the remaining countries.

Finally, the analysis of the clocks on the basis of country-specific infant mortality trajectories displays even three clusters (see Fig. 4d): The leaders with regard to IMORT, i.e. Slovenia (SI) and the Czech Rep. (CZ) form a first small cluster. The laggards Bulgaria (BG), Romania (RO), and Latvia (LV) are together in a second cluster. Finally there is a third main cluster with five countries, all at a medium level of infant mortality IMORT. From the perspective of Table 1, this differentiation is not so surprising. According to this table, the country-specific IMORT-clocks yield extremely heterogeneous assessments of development with regard to infant mortality.

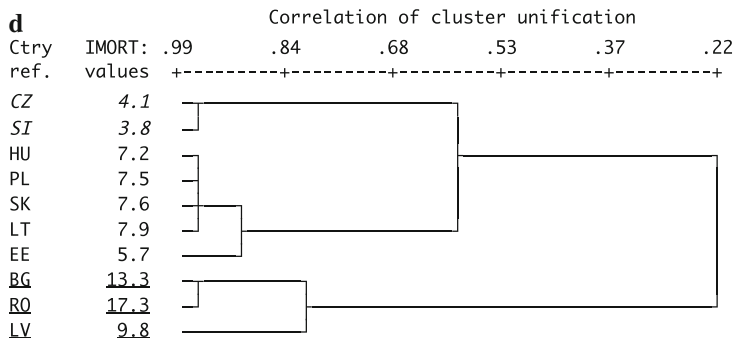
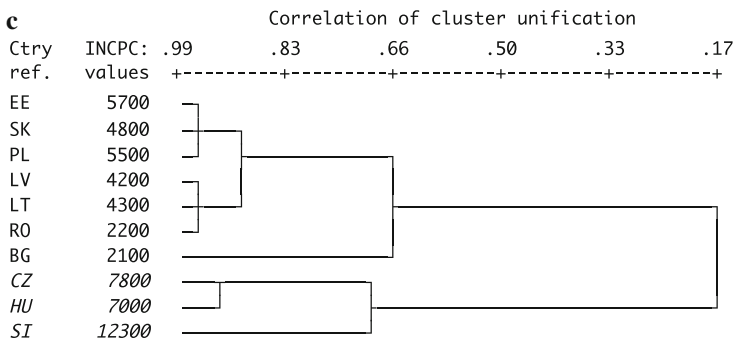
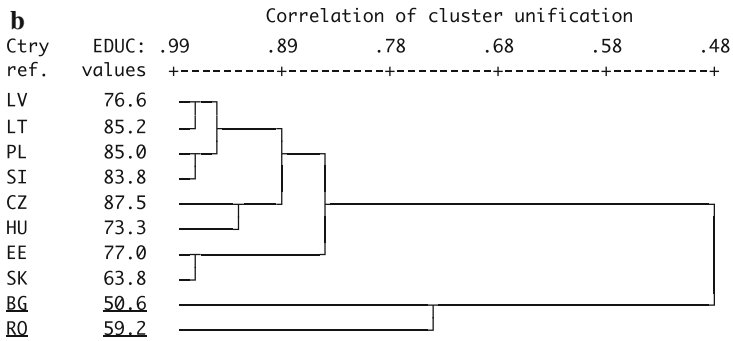
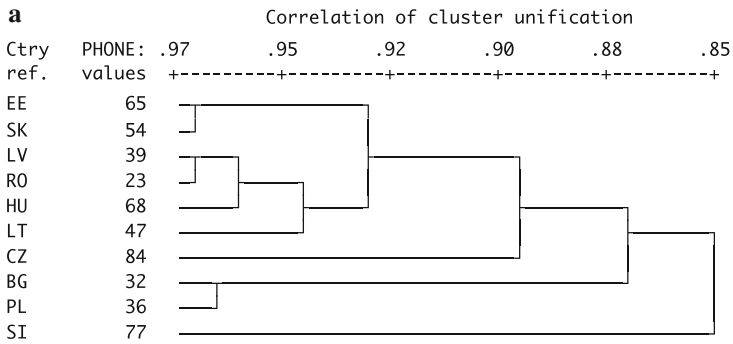


Fig. 4 **a** A cluster analysis of the PHONE-clocks of ten reference-countries. **b** A cluster analysis of the EDUC-clocks of ten reference-countries. **c** A cluster analysis of the INCPC-clocks of ten reference-countries. **d** A cluster analysis of the IMORT-clocks of ten reference-countries. *Legend:* Countries: *BG* Bulgaria, *CZ* Czech Rep., *EE* Estonia, *HU* Hungary, *LV* Latvia, *LT* Lithuania, *PL* Poland, *RO* Romania, *SI* Slovenia, *SK* Slovakia. Proximities: Pearson correlations between two assessments of 10 countries by two country-specific clocks. Method of clustering: Hierarchical clustering, based on the furthest neighbor metric

In sum, the hierarchical cluster analyses of Fig. 4a–d always show one major cluster of countries with reference trajectories at a medium level of development. Occasionally, there are one or two minor clusters representing the perspectives of the more highly developed or the relatively underdeveloped nations. This cluster-structure justifies the decision in Sect. 3.1 to measure social time by “artificial” *median trajectories*: it can indeed be shown that cluster analyses, which also include the median trajectory, always allocate this reference to the mentioned major cluster of countries at a medium level of development. Even better, Table 2 demonstrates that the correlations between the median trajectory and the national reference trajectories are generally also significant for the often deviant clusters of Slovenia, the Czech Rep., Bulgaria, and Romania. There is one minor exception to this regularity: the correlation between the INCPC-time measurements based on the median- and the *Slovenian* reference trajectories is statistically *not* significant (see Table 2).

3.3 The Dimensionality of the Clock Systems

The dimensions of social time are obviously not independent of one another. Development variables can be instrumental for others and asynchronies between variables are often limited by social norms and political expectations (Mueller 2005a, b). Consequently in this article we will investigate, to what extent PHONE-, EDUC-, INCPC-, and IMORT-time are dependent on each other. As we saw in Sect. 2.2, principal component analysis (Kim and Mueller 1998, Tabachnick and Fidell 2007: Chap. 13) of the different time components of the analyzed ten countries can be used in order to determine the dimensionality of social time and to identify systems of highly coupled clocks.

Table 2 Pearson correlations between time-measurements with median- and with country-specific reference trajectories, by type of clock

Country specific ref. trajectories	PHONE-clock	EDUC-clock	INCPC-clock	IMORT-clock
Czech Rep. (CZ)	.960***	.896***	.874***	.705*
Slovenia (SI)	.916***	.983***	.531	.645*
Estonia (EE)	.963***	.981***	.986***	.923***
Hungary (HU)	.955***	.972***	.957***	.988***
Latvia (LV)	.979***	.964***	.954***	.862***
Lithuania (LT)	.958***	.980***	.974***	.989***
Poland (PL)	.974***	.964***	.986***	.998***
Slovakia (SK)	.961***	.955***	.990***	.986***
Bulgaria (BG)	.952***	.879***	.770**	.709*
Romania (RO)	1.000***	.745**	.937***	.585*

Significances (one-tailed tests): *** 0.1%; ** 1.0%; * 5.0%. Number *N* of analyzed pairs of time measurements: PHONE: *N* = 9 to 10; EDUC: *N* = 8 to 10; INCPC: *N* = 10; IMORT: *N* = 10. Common calendar year of all measurements: 2002

The first goal, i.e. the determination of the dimensionality of social clocks, is not so easy, as the results of the principal component analysis are contradictory. According to the *Kaiser-criterion* (Kim and Mueller 1998: 43–44) the factorization should be stopped after the extraction of *one* factor, because thereafter the Lambdas drop below the critical threshold 1 (see Table 3). However, the elbow of the scree plot, which is not shown here, suggests the extraction of a *second* factor (Kim and Mueller 1998: 44–45). As the one-factor solution explains only 79.8% of the total variance, whereas the two-factor solution reaches $79.8\% + 15.9\% = 95.7\%$ explanation, we opted for the *two*-factor solution, which is presented in Table 3.

The Varimax-rotated factor structure of Table 3 suggests that for this data social development has two lead dimensions: PHONE-time and EDUC-time, which are rather independent of one another. EDUC-time constitutes a stand-alone clock system, whereas PHONE-time is strongly correlated with IMORT-time and INCPC-time. The latter clock system represents the classical, materialist approach to socio-economic development, whereas the EDUC-clock is associated with post-materialist self-development and self-actualization (Inglehart 1977, 1997). In Western Europe, one would expect negative correlations between the components of the materialist and the post-materialist clock system, as the latter have begun to replace the former. In Eastern Europe, materialist needs are not yet satisfied and consequently still relevant. However, by cultural diffusion from the West, post-materialism is also already relevant in Eastern Europe. Consequently, the materialist and the post-materialist clock-system are represented in the principal component analysis of Table 3 as two relatively *independent* dimensions, for which we expect considerable asynchronies.

3.4 Monitoring Progress with Social Clocks

Social progress is often monitored by the following three types of comparison:

- Comparisons between differing positions of *countries* with regard to a given developmental variable. Such comparisons give a static picture of the hierarchy of the progress of countries.
- Comparisons between *time points* on the axis of calendar time. This focuses on the classical, dynamic notion of progress and is e.g. used, when the attainment of a *policy goal* has to be assessed.

Table 3 Factor loadings of social clocks, by domain of social development

Clock	Unrotated loadings		Rotated loadings	
	Factor 1	Factor 2	Factor 1	Factor 2
PHONE	0.929	−0.290	<i>0.957</i>	0.177
IMORT	0.962	−0.150	0.921	0.317
INCPC	0.962	−0.087	0.891	0.373
EDUC	0.691	0.721	0.274	<i>0.960</i>
Lambda	3.191	0.634	2.633	1.193
Explained var.	0.798	0.159	0.658	0.298

Method of factor extraction: Principal component. Method of factor rotation: Varimax. Input of principal component analysis: Pearson correlations between time-measurements with PHONE-, IMORT-, INCPC-, and EDUC-clocks for $N = 10$ countries in the calendar year 2002. In italics: Maxima of rotated factor loadings

- c. Comparisons between different *development-variables* of a given country at a certain moment of its history. In the planning of progress, this helps to identify the strengths and weaknesses in the “performance profile” of countries.

With the instrument of social clocks, all these comparisons are possible—and as the example of the ten Eastern European countries will show, such comparisons are often easier to carry out with social clocks than with other methods.

Figure 5 shows the comparisons between the *countries* for the calendar year 2002. As expected, the country rankings vary from one time-dimension to another. In fact, a diagram with the original data from Eurostat (2010b–e) would show the same country ranking. There are, however, features, which make Fig. 5 unique. For example, it separates the underachieving countries from the overachieving ones: left of the threshold 2002 are the countries below the median, right of this value are the overachievers above the median. Moreover, the diagram also reveals how far the countries are above or below the median trajectories: For income per capita (INPC), infant mortality (IMORT), and education (EDUC), this time-distance is often more than 6 years. In contrast, for mobile phones (PHONE), this distance is at most 2 years. Hence, PHONE seems to be a rather unusual variable with regard to the accessibility of status: lags can easily be caught up and leads are limited by stiff international competition.

Table 4 compares three *points of calendar time*, 2000, 2002, and 2004, and derives information about the statistical distribution of the velocity and the acceleration of the development of the analyzed countries. *Velocity* between the calendar years 2000 and 2004 is here defined as the difference between social time in 2004 and 2000, related to the corresponding 4-year change in calendar time (see Sect. 2.1 and legend of Table 4). Regular velocity is thus $4/4 = 1$, rapid change is indicated by velocity >1 , and slow change by velocity <1 . Hence, velocity may be used to evaluate progress with regard to a policy goal: generally, velocity ≥ 1 means that a country is getting closer to such a goal. *Acceleration* is derived from velocity. It is operationalized as the change in partial velocities between the calendar periods 2000–2002 and 2002–2004 (see legend of Table 4). Depending on the sign of acceleration, the velocity between the calendar year 2000 and 2004 can either be steady, decelerating, or accelerating. Neither the velocity nor

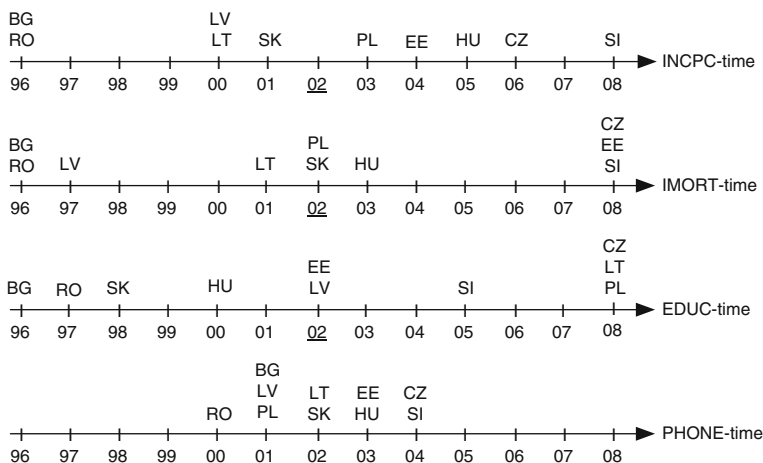


Fig. 5 The comparison of countries on four social time dimensions

Table 4 Velocity and acceleration for the calendar years 2000 to 2004, by social time

	PHONE-time	EDUC-time	INCP-time	IMORT-time
Velocity > 1	bg, ee, lt	bg, cz, lv, lt, pl, si	ee, lt, sk	ee, hu
Velocity = 1	hu, ro, si, sk	–	hu	sk
Velocity < 1	lv, pl	ee, hu	cz, lv, pl	lt, pl
Acceleration > 0	ee, lv, pl	hu	lt, sk	pl
Acceleration = 0	hu, lt, ro, si, sk	lv	–	sk
Acceleration < 0	bg	ee	cz, ee, hu, lv, pl	ee, hu, lt

Velocity = (Social time in 2004 – Social time in 2000)/4. –: No observations. Acceleration = (Social time in 2004 – Social time in 2002)/2 – (Social time in 2002 – Social time in 2000)/2. Countries: *bg* Bulgaria, *cz* Czech Rep., *ee* Estonia, *hu* Hungary, *lv* Latvia, *lt* Lithuania, *pl* Poland, *ro* Romania, *si* Slovenia, *sk* Slovakia. Countries not mentioned in a column have missing values for velocity or acceleration

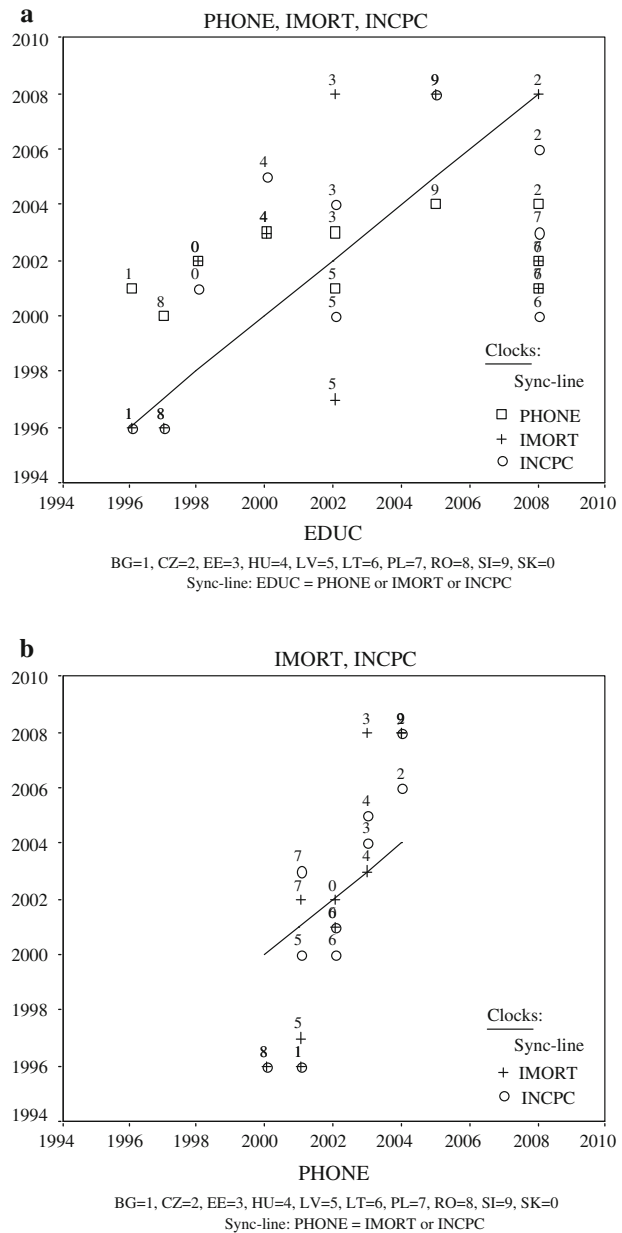
the acceleration depend on the “natural” dynamics of the *original* variables: as Fig. 1 shows, the dynamics of a primary variable not only influences the country trajectory but also the reference trajectory, which is used for measuring social time and which is thus the basis for the derived concepts *velocity* and *acceleration*.

According to Table 4, the four developmental variables analyzed here display rather different dynamics. In the case of PHONE-time, velocity 1 with acceleration 0 prevails. This explains, why in Fig. 5 we see so little inter-country variation for PHONE-time. Education, the new post-materialist value is growing rapidly in many countries (see Table 4, EDUC-time). However, as many values are missing, it is not possible to determine, whether there has also been an acceleration, as would be plausible for a new social value. Similarly, with many missing values, IMORT is also difficult to assess. However, income per capita INCPC was clearly decelerating for many countries in the period between 2000 and 2004: it may be that this phenomenon has to do with the economic insecurity before the integration of most of these countries into the European Union EU in mid 2004.

Figures 6a and b refer to the last type of comparisons, i.e. comparisons between developmental *variables*. Of special interest are in this context the two clock-systems identified by the principal component analysis presented in Table 2. The statistical independence of the EDUC-clock from the PHONE-, IMORT-, and INCPC-clock suggests the existence of substantial asynchronies between the two clock systems. As Fig. 6a demonstrates, there are indeed considerable asynchronies, which can reach 8 or more years. The number of asynchronies with a leading EDUC-time is practically the same as the number of asynchronies where EDUC-time lags. There is, however, a further regularity in Fig. 6a: where EDUC-time is for a given country ahead with regard to *one* of the remaining dimensions of development, it is also ahead with regard to *all others*. And similarly, if for a given country EDUC-time lags behind *one* of the remaining dimensions, it also lags behind *all others*. This regularity may have to do with the fact that PHONE-time, IMORT-time, and INCPC-time are highly correlated due to their adherence to the same clock system (see Table 3).

The correlation between the time-dimensions of a clock system does not preclude the existence of important asynchronies between these time-dimensions. Figure 6b illustrates this for the relationship between PHONE-time on the one hand and INCPC- and IMORT-time on the other: the relation is indeed linear, but the slope of this linear function is different from 1 and thus generates many systemic asynchronies. If INCPC- or IMORT-time is below 2002, PHONE-time is generally the leading dimension of the mentioned

Fig. 6 a, b Asynchronies between the times of four social clocks



asynchronies (see Fig. 6b): mobile phones are highly accessible, even for less developed countries. However, if INCPC- or IMORT-time is above the 2002 threshold, PHONE-time becomes a lagged dimension: growth-rates on the PHONE-dimension are limited by international competition, even for the more developed countries above the mentioned 2002 threshold.

4 Summary and Conclusions

The study of socio-economic progress by means of social clocks demonstrates the *relativity* of development in at least two ways:

a) There is not only one, but there are many alternative *reference trajectories* for constructing social clocks and monitoring socio-economic progress. Each reference gives a different picture of social development, where the most particular pictures are expected for very fast and very slow, or very high and very low reference-trajectories (see Fig. 3). Especially the second part of this regularity seems to hold for Eastern Europe too. However, for these countries we have been able to demonstrate that most national reference trajectories are related to each other by linear functions (see Fig. 4a–d) so that at least some of the empirical results of this article should be valid independently of the reference trajectories used.

b) In principle there are as many *clocks* as there are development dimensions and each of these clocks may point to a different time. Thus, development is a multidimensional concept with numerous asynchronies and leads and lags between indicators of development. Consequently, a country can *simultaneously* be in the *present* and in the *past*, depending on which social clock is the focus of analysis. Fortunately, time-measurements given by different clocks are often correlated and can be investigated by principal component analyses. In the case of Eastern Europe, it turns out that social development time is two-dimensional (Table 3): there is a traditional development dimension represented by the mobile phone clock and a post-materialist time axis represented by the education clock.

The relativity of development is not caused by the use of social clocks but is rather made more transparent by this type of analysis. Social time is a *unifying* concept that enables all kinds of new comparisons, which previously were difficult or even impossible to carry out. In addition, time is also an *intuitive* concept, which gives these comparisons an everyday meaning and thus makes the relativity of social development more understandable.

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